

REMARKS

In the Office Action, the Examiner noted that claims 1-6 were pending in the application and the Examiner rejected all claims. By this Amendment, various claims have been amended and claim 2 has been cancelled. Thus, claims 1, and 3-6 remain pending in the application. The Examiner's rejections are traversed below.

THE ABSTRACT

In items 2 and 3 on page 2 of the Office Action, the Examiner objected to the length of the Abstract. The Abstract has been amended in accordance with the Examiner's comments.

THE PRIOR ART REJECTIONS

In item 5 on pages 3 and 4 of the Office Action, the Examiner rejected claims 1 and 3-6 under 35 U.S.C. § 102 as anticipated by U.S. Patent 4,402,053 to Kelley et al. In item 7 on page 5 of the Office Action, the Examiner rejected claim 2 as unpatentable over Kelley et al. in view of U.S. Patent 6,597,971 to Kanno.

The Kelley et al. Reference

The Kelley et al. reference is directed to a robot assembly in which a robot hand engages a workpiece at a selected holdsite. The workpiece is moved to a pose where the position and orientation of the workpiece are determined. Then, the workpiece may be disengaged or moved to an intermediate or final goalsite (see Abstract). Referring to Figs. 2 and 5, a first camera 42 is used to select holdsites on workpieces 80 in a bin 82. Because the camera is mounted on an arm, it can be used to view workpieces nearly anywhere in the bin 82 and goalsites 100, 110 and 130. A second camera 44 is used to compute a workpiece presentation pose in the hand 26 (col. 7, lines 14-19). Kelley et al. discusses workpiece model matching involving computing image features necessary to determine orientation of the workpieces in the hand. The hand holds the workpiece and the assembly moves to a first presentation pose. Next, an image of the workpiece is formed using the work station camera, and image features are extracted. Their locations are computed and stored along with their properties. Then, the assembly moves the workpiece to the second presentation pose. Another image of the workpiece is formed using the workstation camera and image features are extracted. Their locations are computed and stored along with their properties. Features appearing in both images are paired and located in the

space by using the camera model. The feature points and space are matched to pre-established workpiece features point model to determine the hand-workpiece relationship. The assembly then moves to a goalsite via the through pose and places the piece within the proper pose at the goal. (Col. 13, lines 16-35)

THE PRESENT CLAIMED INVENTION PATENTABLY DISTINGUISHES OVER THE PRIOR ART

The present claimed invention as set forth in claim 1 is directed to a workpiece conveying apparatus comprising a robot having a hand to grip a workpiece and conveying the workpiece, and a visual sensor. The visual sensor includes image pickup means for capturing an image of a characteristic portion of the workpiece while the workpiece is moved by the robot to a release position. The visual sensor also includes position detecting means for detecting, on the basis of the image of the characteristic portion obtained by the image pickup means, a position of the characteristic portion of the workpiece observed when the image is captured. The visual sensor recognizes the grip state of the workpiece while the workpiece is being moved by the robot to the release position, on the basis of the positions of the robot and the characteristic portion of the workpiece when the image is captured. The workpiece conveying apparatus also includes means for storing in advance a predetermined grip state established by the hand of the robot and mean for comparing the predetermined grip state with the grip state recognized by the visual sensor when the image is captured and determining an error. The apparatus further includes means for stopping the robot when the error exceeds a predetermined tolerance limit or for issuing a signal indicative of a fault.

The above features are not taught or suggested by Kelley et al. because Kelley et al. describes an arrangement in which workpieces are moved and then stopped at pose positions so that images of the workpiece can be formed. In contrast, in accordance with the present claimed invention of claim 1, the workpiece gripped state established by the hand can be observed while moving the robot. Further, the deficiencies of Kelley et al. are not cured by U.S. Patent 6,597,971 to Kanno. Thus, it is submitted that neither Kelley et al. nor Kanno teach or suggest the claimed workpiece conveying apparatus of claim 1 including:

a robot having a hand to grip a workpiece and conveying the
workpiece; and
a visual sensor, comprising:

image pick-up means for capturing an image of a characteristic portion of the workpiece while the workpiece is being moved by said robot to a release position;

position detecting means for detecting, on the basis of the image of the characteristic portion obtained by said image pick-up means, a position of the characteristic portion of the workpiece observed when the image is captured,

said visual sensor recognizing the gripped state of said workpiece while the workpiece is being moved by the robot to the release position, on the basis of the positions of the robot and the characteristic portion of the workpiece when the image is captured;

means for storing in advance a predetermined gripped state established by the hand of said robot;

means for comparing the predetermined gripped state with the gripped state recognized by said visual sensor when the image is captured, and determining an error; and

means for stopping the robot when the error exceeds a predetermined tolerance limit or for issuing a signal indicative of a fault.

Therefore, it is submitted that claim 1 patentably distinguishes over Kelley et al and Kanno.

It is also submitted that neither Kelley et al. nor Kanno et al. teach or suggest the features of claim 3 which include:

a robot having a hand to grip a workpiece and conveying the workpiece; and

a visual sensor, comprising:

image pick-up means for capturing an image of a characteristic portion of the workpiece while the workpiece is being moved by said robot to a release position; and

position detecting means for detecting, on the basis of the image of the characteristic portion obtained by said image pick-up means, a position of the characteristic portion of the workpiece observed when the image is captured,

said visual sensor recognizing the gripped state of said

workpiece while the workpiece is being moved by the robot to the release position, on the basis of the positions of the robot and the characteristic portion of the workpiece when the image is captured;

means for storing in advance a predetermined gripped state established by the hand of said robot;

means for comparing the predetermined gripped state with the gripped state recognized by said visual sensor to determine an error; and

means for correcting the release position to which said robot conveys the workpiece, on the basis of the error.

Therefore, it is submitted that claim 3 patentable distinguishes over Kelley et al. and Kanno.

Claims 4-6 depend, directly or indirectly from claim 1 or claim 3 and include all the features of the claim from which they depend, plus additional features which are not taught or suggested by the prior art. Therefore, it is submitted that claims 4-6 patentably distinguish over the prior art.

"MEANS FOR" LANGUAGE

In item 8 on pages 5 and 6 of the Office Action, the Examiner requested that the Applicants state whether the "means for" language inserted in the claims is meant to invoke 35 U.S.C. § 112, 6th paragraph. Applicants expressly state their desire to invoke 35 U.S.C. § 112, 6th paragraph with respect to the claim features stated in terms of "means for".

SUMMARY

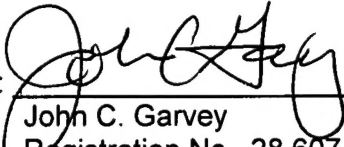
It is submitted that none of the references, either taken alone or in combination, teach the present claimed invention. Thus, claims 1 and 3-6 are deemed to be in a condition suitable for allowance. Reconsideration of the claims and an early notice of allowance are earnestly solicited.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

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